

The Effects of Computerized Assessment on Achievement in Mathematics

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Abstract

This action research project has investigated the effects of computerized assessments in a middle school math course. The goal of this project was to see what impact computerized assessments had on student achievement as well as how this correlates with student opinion. Student subjects from an 8th grade Algebra course were given assessments in traditional paper/pencil format and also a computerized format. The researcher observed and evaluated student subjects through multiple assessments, quizzes and tests, in both paper and computerized formats. A pre-study survey and post-study survey had been used to determine which method of assessment the student subjects found more favorable. Results of the assessments are being compared and analyzed to support and justify converting future assessments to a computerized format.

The Effects of Computerized Assessments on Achievement in Mathematics

Introduction

The Research Question

Educators today are faced with many challenges and requirements of student achievement. From local school boards to the President of our country we are pressured to have proof of student achievement and that proof has come in the form of test scores. While many would debate the validity of assessments and standardized tests, for example the Wisconsin Knowledge and Concepts Exam (WKCE), nobody can ignore the fact that these exist. Many things may be factors of student success or lack of success on these tests. Some of these include time constraints, individual learning styles and student attitudes about testing. This has lead educators to question which methods of assessment are truly valuable and beneficial to students achieving the highest possible scores.

Before the integration of technology in our schools, students were assessed in their classrooms by using traditional methods such as responding in writing to a written set of questions or writing answers to verbal questions. With new technologies have come new methods for assessing and evaluating student learning. This has enabled educators to reach the learning styles of all students not in just the instruction of material but also in the evaluation of the learning that has taken place. Also, online testing has capabilities of providing immediate feedback to students and teachers. When considering all of the factors and the ability to complete computerized assessments, one should ask if students achieve higher scores on computerized assessments than on the traditional assessments.

Purpose and Rational

Many adjustments are being made in regard to how educators provide instruction of material to their students. Technology is being incorporated into the lessons of many teachers at all age levels. Interactive whiteboards have become a prevalent way of getting students more involved and active in their learning. Audio and video resources are being used reach students and their different learning styles. Computer game software is being used as a method for students to practice skills in a more exciting and fun way. With the changes to instructional methods have come changes in assessment methods as well. Computer technologies have allowed educators the capability to assess student learning in a whole new way. Some programs provide instant and immediate feedback to students as each question is answered. Others are programmed to vary the level of difficulty of the questions based on students' previous responses. What is unclear is if these different, more technological methods of testing provide students with the opportunity to obtain higher scores than they would achieve with a traditional paper and pencil assessment.

As mentioned above, educators are pressured by local and national politics to have their students produce high test scores. Not all school districts are able to provide the same level of technology for their students; not all areas of the nation are using the same method for obtaining their standardized test scores. If indeed the computerized form of assessment yields better scores one can conclude that some schools have an unfair advantage. In this study the researcher provided the opportunity for eighth grade students to take their math assessments in both paper/pencil format as well as an online computerized format. The results of these have been compared and analyzed to see if one method produces higher scores. If indeed a computerized assessment format would yield better results the researcher would use the information to

advocate for change in the way standardized test scores are obtained. This knowledge would also lead to changes in regular assessments in math class if the study shows it to be beneficial for student achievement.

Review of Literature

As I searched for literature on the topic of computerized assessment I found that the information available is quite broad. New innovative approaches to teaching and learning have been applied in classrooms and as a result terms like distance learning, online testing and e-assessments have begun to appear as topics in research studies around the world. What I have discovered through reading various articles is that not all the research that has been done is in support of using technology for assessment. What most researchers and experts seem to agree on is that both technology and assessments are a valuable part of today's education system, therefore it is necessary to determine the most effective way to use both. I have focused on articles and research that concludes one method of testing is better than the other as well as those that highlight some benefits of online assessment to both student and teacher.

Research has shown that one of the benefits to online or computerized assessments is the capability to provide immediate feedback to students and teachers. In the article *Pick and Click: Interactive Assessment Goes to School* written by Mark Nichol in 2007, California schools have started implementing interactive software for lessons and assessments. Technology coordinator in Los Angeles Nicole Miller discusses such systems and refers to them as providing validation on the spot for both teachers and students (Nichol, 2007). They know if responses are correct or incorrect the instant they are submitted and the computer tracks all of the records. David Collier, a teacher in California uses the system to replace multiple-choice paper tests and notes the instant feedback as one of his favorite features (Nichol, 2007). Since our students are part of a

generation that grew up with instant access and instant information they expect that in a school setting as well. Jukes and McCain (2007) discuss this in their article *Windows On the Future*.

Such everyday expectations have led to the death of patience and the emergence of a society increasingly expecting, wanting and demanding instant gratification. This is one of the reasons why it's harder and harder to get read today. Reading is a delayed gratification medium while TV, video games and the Web are immediate gratification media.

This same benefit of feedback was discussed in *Does Regular Online Testing Enhance Student Learning in Numerical Sciences? Robust Evidence from a Large Data Set* written by Simon Angus and Judith Watson in 2009. "Instructors are attracted by savings in both marking time and administrative costs of mark compilation, while for students, online quizzes give instantaneous and detailed feedback..." (Angus and Watson, p.255). These sources show that the teachers are enjoying the capabilities of instant feedback as much as the students are expecting it. Along with this is the fact that educators today are reaching out to the different learning styles of students with the instruction and delivery of the material. Experts assert that this should be met with assessments to match the learning styles. In *Network-Based Assessment in Education* written by David Gibson in 2003, many different assessment types were analyzed and compared to traditional assessment. "...there is a unique new potential for network-based assessments to measure what students and teachers know and can do. The forms of delivery and interactions are dramatically different from traditional assessments, giving rise to new possibilities for forms of collecting and analyzing information that are better aligned with what we know about how people learn." (Gibson, 2003)

Other research studies on computerized assessment make claims either for or against the effectiveness of it compared to traditional paper/pencil methods. One article (“Studies in Success: A survey of Assessment Research,” 2002) discusses a study conducted by Boston College’s Center for the Study of Testing, Evaluation, and Educational Policy. This study makes the claim that traditional assessment methods are ineffective in measuring student abilities. They assert a reason for this to be that contemporary students are living in a digital world and therefore pencil/paper doesn’t fit their learning styles. Another study (Angus & Watson, 2009) makes the claim that their research shows higher student achievement with online assessments.

On the other hand I have read some research that suggests online assessment does not significantly improve student achievement and may actually have the reverse effect. In *Improving Student Performance Through Computer-based Assessment: insights from recent research* by C. Ricketts and S.J. Wilks, they studied student performance on summative assessments in online formats and traditional formats. The study led them to a conclusion as follows: “Analysis of student results in the two years showed that students using online assessment did not perform as well as those using OMR-marked multiple-choice questions, even when the same questions were given to the students.” (Ricketts and Wilks p. 475). The authors do go on to assert that it may have been the fact that the testing method was new and foreign to the students which may have impacted the results. This issue was also addressed by researchers Grainne Conole and Bill Warburton in *A Review of Computer-Assisted Assessment* written in 2005. They discuss that research has been done comparing the traditional paper and pencil assessment to computer-based assessments but that there are too many factors such as test-taking experience of the students and formation of the assessment questions that make it inappropriate to say one method is more effective than another (2005).

The information I have gathered supports the need for continuing research in this area. Though it seems that the literature on computerized assessment is inconclusive I am certain that I will find information through my research that will provide further insight to whether or not computerized testing proves beneficial to students. Experts certainly disagree on the best way to assess student learning, however, what a majority of educators can agree on is that it is imperative that not only the diverse learning styles are being met but also the diverse testing styles.

Design of Study

Participants

This study took place at Lakewood School in Twin Lakes, Wisconsin. Twin Lakes is a rural community in Southeastern Wisconsin. Lakewood School is a K-8 school that has a population of 444 students. The student body is 88% Caucasian with 33% enrolled in a free/reduced lunch program. Approximately 10% of the students qualify for services to accommodate a disability.

The participants in this study came from the researchers eighth grade Algebra 1 class, which consisted of nineteen of the fifty-one eighth graders at Lakewood School. Of these students, six were male and thirteen were female. The student subjects ranged in age from thirteen to fourteen years. One of the female students in this class was of Native American descent.

The researcher has made all possible efforts to maintain integrity in the study as well as confidentiality of the student subjects. Before the study was performed the researcher completed CITI training and obtained approval from the IRB (Appendix A) of Marian University. Permission was given to the researcher from the district administrator (Appendix B) of

Lakewood School. Parents of all nineteen student subjects signed a parental permission letter (Appendix C) and each student signed the student assent form (Appendix D).

Instruments

One tool used in collecting data was a Pre-Study Survey (Appendix E). The information gathered with this tool was both qualitative and quantitative. One of the issues of assessment the researcher wished to examine was student attitudes about the different methods of assessment. This survey was designed to give the researcher an idea of what types of assessments the students had been exposed to as well as their general feelings about the different types. For qualitative data, the students were instructed to mark each method of assessment that they were familiar with and then select the one type that they felt gave them the most opportunity for success. They then ranked their personal preference of the four test types provided which gave the researcher quantitative data. The same survey was given to the students as a Post-Study Survey (Appendix F) to see if the attitudes about the assessment methods had changed based on the experiences and successes they had during the study.

Another source of quantitative data was the assessments themselves. A paper format of the Chapter Two Quiz (Appendix G) was developed by the researcher to measure the use of skills learned in the first five lessons of Chapter Two in the Holt Algebra 1 text. The quiz consisted of computation problems as well as application and word problems. This version of the quiz required students to show all of their work on the paper that they would be turning in. The students were also given an online version of the same quiz (Appendix H) where they simply typed in the answer to the questions. The researcher was then able to compare the two sets of scores to provide insight into which method provided the students with opportunity for achieving higher scores. The same thing was done with two more tools, a paper version of the

Chapter Two Test (Appendix I) and a replica of that in an online format (Appendix J). These tools provided much quantitative data for the researcher to compare and contrast.

Procedure

The study took place over the course of six weeks. Prior to the start of the study, the students had already begun learning the content of the chapter being used. They were given the Pre-Study Survey after the permission forms were signed; all students completed the survey in class. After lesson five of Chapter Two was taught the students reviewed the lessons as is customary practice in the class. The first assessment the participants were given was the Chapter Two Quiz in the computerized format. All nineteen students completed this quiz in the school library on a Friday morning. They were provided with written instructions of how to log on to the quiz and some scrap paper to use if needed. This quiz was graded only on the answers that students provided. Each answer was worth one point. The next Monday the students were given the paper form of the Chapter Two Quiz. This format was graded not only on the answer given but the work that was supporting the answer. The whole class completed this version of the quiz on the same day in the regular classroom. After both formats were complete and scored, the students were given the results. The data from both assessments was used in the study; however, the student's were given the higher of the two scores for their class grade.

The second phase of the project began with the learning and practicing of the concepts in lessons six through ten of the chapter. During this phase the students had also been involved in taking the WKCE testing which caused some schedule changes. As a result of this, the chapter lessons took longer than usual to complete. At the end of the chapter the students spent time reviewing and practicing concepts learned throughout the whole chapter. They were then given the Chapter Two Test in the online format. This assessment was given to all nineteen students in

the school computer lab on a Friday morning. Again, the following Monday the students were given the paper version of the test. The scoring of phase two was identical to that of the first assessments.

After the students had completed all work and assessments on the chapter they were asked to complete the Post-Study Survey during class time. This was filled out by all students after they had time to reflect on the experiences they had during the study with the different assessment types. The information gathered through this survey was used to identify any changes in attitudes that may have occurred since the beginning of the study.

Results of Study

Findings and Conclusions

In analyzing the data collected through the assessments and surveys I have concluded that there is not enough information to support either method of assessment for yielding higher student achievement. The data does suggest that student perceptions and attitudes about different testing methods seem to correlate with the method that they experience success with. The details of this will be explained further in the conclusions. The following are the results that were collected.

The first assessment was the quiz on the beginning lessons of Chapter 2. Three of the nineteen students had a higher score on the computer version of the quiz as seen in Fig 1 below. A majority of the students, in fact, performed significantly better on the paper version of the quiz, scoring an average of nine percentage points higher.

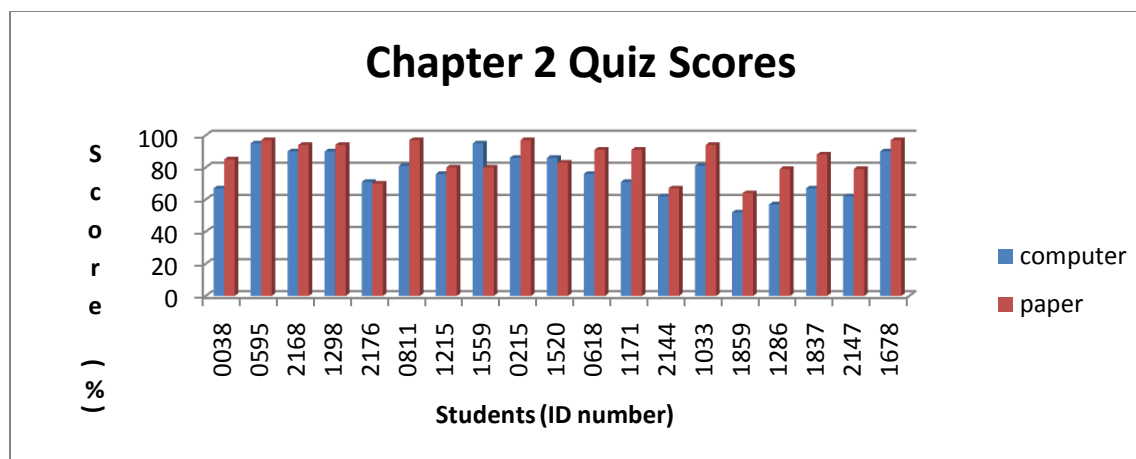


Figure 1. Chapter 2 Quiz Scores

The second assessment was the final test for the chapter. All students scored higher on the paper version of this assessment as seen in Fig 2 below. The students' scores again were on average around nine percent higher on the paper version of the test. As a point of interest, the student with identification number 1678 scored the same on both versions. A complete list of individual scores for both assessments can be found in the table in Appendix K.

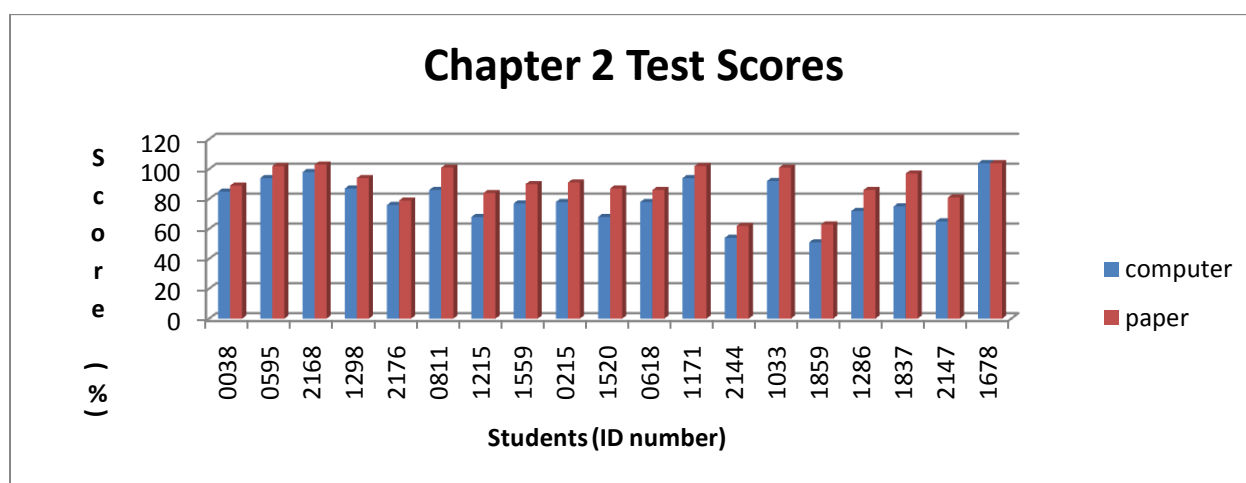


Figure 2. Chapter 2 Test Scores.

These results would seem to support the findings of the research done by C. Ricketts and S.J. Wilks (2002) that had been discussed earlier. Overall, 92% of the assessment scores in my

study were higher on the traditional paper format than on the computer. Although one may be inclined to draw a strong conclusion from those data, there are some factors that I believe are important to consider which will be discussed in my reflection.

At the beginning of the study, students were given a survey about what assessments they have taken and which they thought they performed better on. The results of this survey show a correlation between their preference and the results of the scores data. The majority of the students preferred to take paper and pencil multiple choice assessments; only 5% of the students chose a computer format as shown in Fig 3 below. This information matches the scores fairly well since only 8% of the scores were better on the computer test. Results of the Post-Study Survey, Fig. 4, show that when the assessments were all complete, none of the students chose a computerized format as their first choice which would make sense since it was not a successful format.

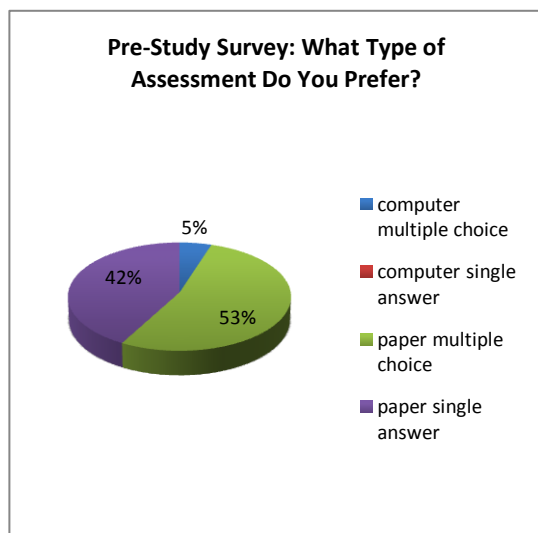


Figure 3. Pre-Study Survey.

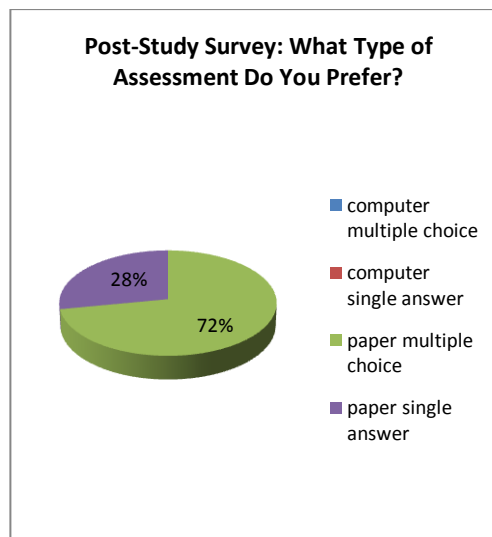


Figure 4. Post-Study Survey.

Some of the literature that was reviewed had made a case for digital assessments based on the fact we are teaching and assessing students that live in a digital world (“Studies in Success: A survey of Assessment Research,” 2002). While this may seem logical, the results of

my study seem to contradict this. All teachers in our school systems are still digital immigrants; therefore the current students have not been exposed to assessments in a computerized format on a consistent basis. Our students are in a digital world but they are also creatures of habit and routine. I believe that those who have had almost all of their assessments given in a traditional format will perform better in that format until they have grown accustomed to a digital assessment.

Another article had discussed the benefits of electronic assessments for the teachers and students (Angus and Watson, 2009). I enjoyed not having to individually grade the computerized tests and being able to see the results immediately. This decreased the amount of time spent on grading and also gave me instant access to results as the tests were finished. Students made mention of this as well and appreciated knowing what grade they received as soon as they submitted their answers. This was truly a benefit to my students and I.

As I had concluded from the review of literature on this subject, further research still needs to be done to make a strong case for computerized assessment. My data collected leads me to that same conclusion. My results have shown that my students are very successful with the traditional assessments that they are accustomed to; changing the assessment to computerized did not help them achieve higher scores. In the big picture of assessment, it needs to be remembered that all students have different learning styles. Although this research did not support the use of computerized assessment I think the results do support the fact that differentiation of assessment is important in a classroom to give all students the opportunity to be successful.

Reflection and Action Plan

When I began this research I was looking to see if students would achieve higher test scores if they took their assessments on a computer instead of a traditional paper and pencil test. I had thought that since my students are digital natives and live in a technological world that it would make sense to think they would test better in that environment. My own personal belief was that it would not be better for them because they would take short cuts and not perform the mathematical calculations that they needed to in order to get questions correct. It seems as though my initial beliefs were correct, my students did much better on the traditional tests than on the computer ones and they preferred the traditional tests over the computerized ones as well. I now wonder if my own bias could have played a role in these results. I think that in some respects it has. This group of students had me for math in their seventh grade year as well so they are used to me testing them with paper and pencil formatted assessments. This was a strange experience for some of them and that could have possibly skewed the results.

Another thing I have been considering while analyzing my results is that the results may have been different with another content area. When I test my students in math it is important to see the process, not just the product or the answer. Therefore, multiple choice testing is not effective. I wonder if using this computerized testing would be more beneficial to students in an area like grammar or social studies where multiple choice testing is more logical. It would be important for future research on this topic to include more content areas instead of being focused on just mathematics.

In reflecting on the process of this project, I have identified some limitations of my research. First, the study group was only one section of my math classes. The class size was fairly small so I did not have a lot of data to work with. The data could have been more meaningful with a larger sample size. Second, the students that I worked with were all in the

accelerated math class. This research may be more effective with a more eclectic group of students. Third, during this study I was limited to using the computer lab only when it was available to my class. This made the timing off on when the assessments would take place. That made the review time shorter than normal for one of the assessments and longer than normal for the other.

When I was doing research on this topic and examining literature about it, I was not surprised by the lack of definitive results. It seems that there is a great deal to be said about the ideas and processes of digital testing, however, there has not been any solid proof of its effectiveness. With my own research being inconclusive I can see why this is a problem. Educators are trying to figure out how best to serve students living in a digital world and we need to keep examining things like computerized testing to see if there is indeed a place for it in our teaching.

Through this process I have learned that just because my students are considered to be digital natives I cannot assume that they will all perform better with the use of technology. They are still greatly exposed to traditional practices and will need to be given time to adjust to new technology that I give them. This is an obstacle that I think many researchers will have to deal with during this transition from “old school” to digital teaching practices.

Although my research may not have made a strong case for using computerized testing I do think it had some success. I was able to give my students the experience of a new digital form of assessment, one that will most likely be used in their education in the future. I had the opportunity to take my own teaching reflections and formalize them, comparing my thoughts and findings to that of other educators who were thinking about the same issues. These experiences for my students are important for their growth as learners as well as for me as a teacher.

As I continue through this school year, I am planning on giving my students the option of which assessment type they would like to use. Next year, I will build these types of assessments into my normal teaching activities so that the students will get more experience with it. As I do this, I will continue to monitor and reflect on students' progress as it relates to the assessment types. Although this will not be formal research on the subject, I think it will help me to draw stronger conclusions about what is best for assessment.

My school has recently started using MAP (Measure of Academic Progress) Testing with our students which is computerized testing. I will be discussing my results with the administrators and teachers in my building during our meetings to discuss how we will be using the results of the MAPs. I believe that my research will help support my thought that we should not place students into certain classes based on the results of these tests alone. I will also be sharing my results with the teachers in the elementary grades at my school. I would like to encourage them to use more digital testing methods with their students so that they have increased exposure to it.

In closing, I think that educators need to continue to research assessment types and find ways to make sure we are doing what is best for our students. My research as well as the research of others indicates that there is a need to find out more about how to get the highest results from our assessments. In my teaching I will continue to reflect upon this issue and do what I can to make other teachers aware of this as well. I will differentiate my assessments so that the students in my classroom have more opportunity for success.

References

- Angus, S. & Watson, J. (2009). Does regular online testing enhance student learning in the numerical sciences? Robust evidence from a large data set. *British Journal of Educational Technology*, 40(2), 255-272.
- Conole, G. & Warburton, B. (2005). A review of computer-assisted assessment. *Research in Learning Technology*, 13(1), 17-3.
- Gibson, D. (2003). Network-based assessment in education. *Contemporary Issues in Technology and Teacher Education*, 3(3), 310-323.
- Jukes, I. & McCain, T. (2007) Windows of the future: Thinking about tomorrow today. The Info Savvy Group. Retrieved September 27, 2009, from http://74.125.95.132/searchq=cache:IryKeFNqxOYJ:web.mac.com/iajukes/thecommittedsardine/Articles_files/wofabbreviated.doc+windows+of+the+future+thinking+about+tomorrow+today&cd=1&hl=en&ct=clnk&gl=us&client=firefox-a .
- Nichol, M. (2007, December 19). Pick and click: interactive assessment goes to school. Retrieved October 21, 2009, from <http://www.edutopia.org/print/5088>
- Ricketts, C. & Wilks, S. (2002). Improving student performance through computer-based assessment: Insights from recent research. *Assessment & Evaluation in Higher Education*. 27(5), 475-479.
- Studies in success: A survey of assessment research. (2002, January 21). Retrieved October 21, 2009, from <http://www.edutopia.org/print/938>.

Appendix A

Researcher Name: Laura Erke

Your project titled "*The Effects of Computerized Assessment on Achievement in Mathematics*" has been reviewed by the Marian University Institutional Review Board for the Protection of Human Subjects (IRB). It has been determined that under rules governing protocol review, the project qualifies for expedited review and is approved for one year without modification.

1. If you should make any future changes in the protocol involving 1) method, 2) subjects, 3) informed consent, and/or 4) subject identification, you must submit a protocol modification. Contact the Office of Research and Sponsored Programs for instructions regarding protocol modification.
2. The case number assigned to this protocol is **L091010093Q**; please reference this number in all future correspondence. You are responsible for maintaining all records related to this project for at least three years after completion of the research project.
3. Your protocol approval is valid from 10/12/2009 to 10/11/2010. You will be required to submit an Annual Progress Report (APR) to the IRB. Before your protocol approval period ends, you will be sent an APR form, which must be completed and returned to the Office of Research and Sponsored Programs to disclose the status of the research. You are required to complete this form even if you have completed your research. You may also use this form to request extension of IRB approval for another year.

Please do not hesitate to contact the ORSP (orsp@marianuniversity.edu or 920-923-8976) if you have questions or require additional information.

MARC HEIMERL, IRB Secretary

Office of Research and Sponsored Programs

Marian University

45 S. National Avenue; Room R006

Fond du Lac, WI 54935

Telephone: 920-923-8796

Fax: 920-926-2114

www.marianuniversity.edu/irb

Appendix B

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Appendix C

Marian University School of Education

Study Title: The Effects of Computerized Assessment on Achievement in Mathematics

Researchers:

- *Laura Erke, 7th and 8th Grade teacher, Lakewood School, 262-877-2148, erke@twinlakes.k12.wi.us*
- *Jenna Linskens, Instructor, Marian University, 920-540-7629, jalinskens67@marianuniversity.edu*

You are being asked to allow your child to take part in a research study carried out by *Laura Erke and Jenna Linskens*. Please read this form carefully, taking as much time as you need. Ask the researcher to explain anything you don't understand. This study has been approved for human subject participation by the Marian University Institutional Review Board (IRB).

You may refuse to give permission, or you may withdraw your permission for your child to be in the study, for any reason. Your child will also be asked if he or she would like to take part in this study. Even if you give your permission, your child can decide not to be in the study or to leave the study at any time.

What is this research study about?

This research study is being done to determine if middle school students will be more successful with tests and quizzes in Algebra class if they are administered in a computerized format as opposed to a more traditional paper and pencil format. The study will also examine the students' attitudes about different assessment styles.

We are asking your permission for your child to be in the study because he/she is a middle school student currently taking Algebra 1 for their math course

Taking part in the study will take about 5 weeks.

Your child cannot take part in this study if he or she is not in the Algebra 1 course at Lakewood School.

What will my child be asked to do if he or she is in this research study?

If your child takes part in the study, he or she will be asked to first complete a pre-study survey that will take approximately 5 minutes of class time. This survey will be asking your child about his or her feelings and experiences with different types of testing. Throughout the chapter he or she will complete a quiz and test on the topics being studied just as the class has done in previous chapters. Your child will take these assessments in one of two forms, traditional pencil and paper or computerized. All assessments will be done during the students' normal math class time. After the chapter, your child will complete a 5 minute post-study survey in class to see if

there were any changes in his/her feelings about the different forms of assessment. The entire study will be completed within 5 weeks of its start.

Your child will have the right to refuse to answer any questions on the surveys, quiz, or test. Results of your child's quiz and test will be provided to him/her during class. Any further results of the study will be available to you and your child upon request.

Are there any benefits to my child if he or she is in this research study?

The potential benefit to your child for taking part in this study is discovering a more effective method for him or her to take tests and quizzes in math class.

If your child takes part in this study, it may help others in the future to be more successful in math class.

Are there any risks to my child if he or she is in this research study?

The potential risk to your child from taking part in this study is a loss of confidentiality, although unlikely.

Will information about my child be kept private?

The data for this study will be kept private and confidential to the extent allowed by federal and state law. Your child's data will be collected by use of their name since the results of the quiz and test will be part of his or her math grade. The researchers will then assign code numbers to your child's data for purposes of analyzing and comparing the data. The coded list will be kept separate from the data and will be available only to the researchers and school staff and the Institutional Review Board. All study data will be kept in a locked cabinet in room 133 of Lakewood School. All conversations and interaction with your student regarding their data will be done privately between the researcher and the student. The results of your child's quiz and test will be given to him or her and will be available to you upon request.

The results of this study may be published or presented at professional meetings, but your child's name will not be used or associated with the findings. The data for this study will be kept for 3 years.

Are there any costs or payments for your child being in this research study?

There will be no costs to you or your child for taking part in this study. You will not receive money or any other form of compensation for taking part in this study.

What are my child's rights as a research study volunteer?

Your child's participation in this study is completely voluntary. Your child may choose not to take part in this study, choose not to answer specific questions, or leave the study at any time. If your child chooses not to participate he or she will still take part in regular classroom activities, but his or her information will not be used in the study.

There will be no penalty or loss of benefits to which you or your child are entitled if you choose not to give your permission for your child to take part or your child withdraws from the study.

Who can I talk to if I have questions?

If you have questions about this study or the information in this form, please contact the researchers, Laura Erke, Lakewood School, 1218 Wilmot Ave, Twin Lakes, WI 53181; erke@twinlakes.k12.wi.us; 262-877-2148 or Jenna Linskens, Marian University, 45 S. National Avenue, Fond du Lac, WI 54935; jalinskens67@marianuniversity.edu, 920-540-7629. If you have questions about your rights or your child's rights as a research participant, or would like to report a concern or complaint about this study, please contact the Marian University IRB Administrator at (920) 923-8796, or e-mail orosp@marianuniversity.edu, or regular mail at: Marian University ORSP, 45 S. National Avenue, Fond du Lac, WI 54935.

What does my signature on this consent form mean?

Your signature on this form means that:

- You understand the information given to you in this form
 - You have been able to ask the researcher questions and state any concerns
 - The researcher has responded to your questions and concerns
 - You believe you understand the research study and the potential benefits and risks that are involved for your child.
 - You understand that even if you give your permission, your child may choose not to take part in the study.
-

Study Title: The Effects of Computerized Assessment on Achievement in Mathematics

Researchers: Laura Erke and Jenna Linskens

Statement of Consent

I give my voluntary permission for my child to take part in this study. I will be given a copy of this consent document for my records.

Signature of Parent or Guardian

Date

Printed Name of Parent or Guardian

Statement of Person Obtaining Informed Consent

I have carefully explained to the parent of the child being asked to take part in the study what will happen to their child.

I certify that when this person signs this form, to the best of my knowledge, he or she understands the purpose, procedures, potential benefits, and potential risks of his or her child's participation.

I also certify that he or she:

- Speaks the language used to explain this research
- Reads well enough to understand this form or, if not, this person is able to hear and understand when the form is read to him or her
- Does not have any problems that could make it hard to understand what it means for his or her child to take part in this research.

Signature of Person Obtaining Consent

Date

Printed Name of Person Obtaining Consent

Person's Role in Research study

Appendix D

Marian University School of Education

Study Title: The Effects of Computerized Assessment on Achievement in Mathematics

Researchers: Laura Erke, Teacher-Lakewood School, 262-877-2148
Jenna Linskens, Instructor-Marian University, 920-540-7629

My name is Laura Erke. I am from Marian University. I and the other people listed at the top of this form are inviting you to take part in a research study. Your parent(s) know we are talking with you about the study. This form will tell you about the study to help you decide whether or not you want to take part in it.

What is this study about?

In this study, we want to learn about how different types of tests affect the achievement of kids your age in math class.

What am I being asked to do?

If you decide to be in the study, we will ask you to complete a survey on how you feel about and your experiences with different types of tests. You will take a chapter quiz and test either in a computer form or pencil and paper form. Then you will complete a survey to see if your feelings have changed.

What are the benefits to me for taking part in the study?

If you take part in this study, you might learn what method of test taking is best for you. It also may help us learn how to help other students be more successful in math class.

Can anything bad happen if I am in this study?

We think that there is a small risk to you by being in the study. As with all scores in class, your results on the quiz and test will not be shared with the class, however, there is a chance that your scores could become known by others. The results will be kept in a locked cabinet and your name will be turned into a code number after they are scored to help prevent anyone from seeing your scores.

Who will know that I am in the study?

We won't tell anybody that you are in this study and everything you tell us and do will be private and confidential. Your parent may know that you took part in the study, but we won't tell them anything you said or did, either. When we tell other people or write articles about what we learned in the study, we won't include your name or that of anyone else who took part in the study.

Do I have to be in the study?

No, you don't. The choice is up to you. No one will get angry or upset if you don't want to do this. And you can change your mind anytime if you decide you don't want to be in the study anymore. If you decide to not be in the study, you will still take part in the activity but your answers and scores will not be used in the study.

What if I have questions?

If you have questions at any time, you can ask us and you can talk to your parent about the study. We will give you a copy of this form to keep. If you want to ask us questions about the study, call or email Mrs. Erke, 262-877-2148, erke@twinlakes.k12.wi.us

The Marian University Institutional Review Board has reviewed this study to make sure that the rights and safety of people who take part in the study are protected. If you have questions about your rights in the study, or you are unhappy about something that happens to you in the study, you can contact them at (920) 923-8796 or orsp@marianuniversity.edu.

Do you have any questions about the study now?

Study Title: The Effects of Computerized Assessment on Achievement in Mathematics

Researchers: Laura Erke and Jenna Linskens

IF YOU WANT TO BE IN THE STUDY, SIGN AND PRINT YOUR NAME ON THE LINE BELOW:

Sign your name

Date

Print your name

Statement of Person Obtaining Assent

I have carefully explained to the child taking part in the study what he or she can expect.

I certify that, to the best of my knowledge, the child understands the purpose, procedures, potential risks and benefits of the study and his or her rights as a participant.

I also certify that he or she:

- Speaks the language used to explain the research
- Reads well enough to understand this form or, if not, this child is able to hear and understand when the form is read to him or her
- Does not have any problems that could make it hard to understand what it means to take part in this research.

Signature of person obtaining assent

Date

Appendix E

Pre-Study Survey- Assessment Types

1. I have taken the following types of tests or quizzes for math: (circle all that apply)
 - a) Computerized multiple choice
 - b) Computerized single answer
 - c) Pencil/paper multiple choice
 - d) Pencil/paper single answer

2. I feel that I am most successful with: (Circle only one choice)
 - e) Computerized multiple choice
 - f) Computerized single answer
 - g) Pencil/paper multiple choice
 - h) Pencil/paper single answer

3. Number the following 1-4, 1 being your first choice of test type, 4 being your last.

___ computerized multiple choice
___ computerized single answer
___ pencil/paper multiple choice
___ pencil/paper single answer

Appendix F

Post-Study Survey- Assessment Types

4. I have taken the following types of tests or quizzes for math: (circle all that apply)

- i) Computerized multiple choice
- j) Computerized single answer
- k) Pencil/paper multiple choice
- l) Pencil/paper single answer

5. I feel that I am most successful with: (Circle only one choice)

- m) Computerized multiple choice
- n) Computerized single answer
- o) Pencil/paper multiple choice
- p) Pencil/paper single answer

6. Number the following 1-4, 1 being your first choice of test type, 4 being your last.

- ___ computerized multiple choice
- ___ computerized single answer
- ___ pencil/paper multiple choice
- ___ pencil/paper single answer

Appendix G

Algebra Quiz 2-1 through 2-5

- * All work must be shown to receive full credit.
- * Pencil Only!
- * Calculator is allowed.

Solve.

1. $x - 32 = -18$

2. $1.1 = m - 0.9$

3. $\frac{9}{8} = g + \frac{1}{2}$

4. $\frac{h}{2} = -12$

5. $-2.8 = \frac{w}{-3}$

6. $42 = 3c$

7. $2r + 20 = 200$

8. $\frac{3}{5}k + 5 = 7$

9. $5n + 6 - 3n = -12$

10. $4(x - 7) = 2$

11. $3(2x - 5) = 2(3x - 2)$

12. $2(2t - 3) = 6(t + 2)$

13. A fund-raiser raised \$2400, which was $\frac{3}{5}$ of the goal. Write and solve an equation to find the amount of the goal.

14. A taxicab company charges \$2.10 plus \$0.80 per mile. Carmen paid a fare of \$11.70. Write and solve an equation to find the number of miles she traveled.

15. On the first day of the year, Diego had \$700 in his savings account and started spending \$35 a week. His brother Juan had \$450 and started saving \$15 a week. After how many weeks will they have the same amount? What will that amount be?

Solve for the given variable.

16. $2x + 3y = 12$ solve for x .

17. $\frac{x}{r} = v$ solve for x .

18. $5j + s = t - 2$ solve for t .

19. $h + p = 3(k - 8)$ solve for k .

Appendix H

Algebra Chapter 2 Quiz

Quiz on lesson 2-1 through 2-5

1. $x - 32 = -18$ (1 point)

2. $1.1 = m - 0.9$ (1 point)

3. $9/8 = g + 1/2$ (1 point)

4. $h/2 = -12$ (1 point)

5. $-2.8 = w/-3$ (1 point)

6. $42 = 3c$ (1 point)

7. $2r + 20 = 200$ (1 point)

8. $3/5k + 5 = 7$ (1 point)

9. $5n + 6 - 3n = -12$ (1 point)

10. $4(x - 7) = 2$ (1 point)

11. $3(2x - 5) = 2(3x - 2)$ (1 point)

12. $2(2t - 3) = 6(t + 2)$ (1 point)

13. A fundraiser raised \$2400, which was $\frac{3}{5}$ of the goal. Write and solve an equation to find the amount of the goal. (2 points)

14. A taxicab company charges \$2.10 plus \$0.80 per mile. Carmen paid a fare of \$11.70. Write and solve an equation to find the number of miles she traveled. (2 points)

15. On the first day of the year Diego had \$700 in his savings account and started spending \$35 a week. His brother Juan had \$450 and started saving \$15 a week. After how many weeks will they have the same amount? (1 point)

16. $2x + 3y = 12$ solve for x (1 point)

17. $x/r = v$ solve for x (1 point)

18. $5j + s = t - 2$ solve for t (1 point)

19. $h + p = 3(k-8)$ solve for k (1 point)

Appendix I

Algebra Test
Chapter 2

*** You must show ALL your work to receive full credit!**

*** Pencil Only!**

*** Calculator is allowed**

Solve each equation for the variable (1 pt each)

1. $t + 5 = -35$

2. $20 = -12 + v$

3. $b + 32 = 220$

4. $u - 15 = -8$

5. $-\frac{1}{6} + h = \frac{1}{6}$

6. $\frac{x}{2} = 12$

7. $2.4 = \frac{b}{5}$

8. $-52 = -4c$

9. (2 pts) The school band needs \$1680 to travel to a competition. They have already raised \$560.

a) Write an equation that shows how much money they need to earn.

b) Solve the equation to find how much money they still have to raise.

Solve each equation for the variable (2 pts each)

10. (2pts) An orange contains about 80 milligrams of vitamin C, which is 10 times as much as an apple contains.

a) Write an equation that shows how much vitamin C is in an apple.

b) Solve the equation to find out how much vitamin C is in an apple.

Solve each equation for the variable given (2 pts each)

11. $3a + 12 = 30$

12. $2r + 20 = 200$

13. $5n + 6 - 3n = -12$

14. $\frac{3}{5}k + 5 = 7$

15. $3x + 15 - 9 = 2(x + 2)$

16. $3(2x - 5) = 2(3x - 2)$

17. (2pts) Justin and Tyler are beginning an exercise program to train for football. Justin weighs 150 lbs. and hopes to *gain* 2 lbs. per week. Tyler weighs 195 lbs and hopes to *lose* 1 lb. per week.

a) Write an equation that shows when the boys will weigh the same.

b) Solve the equation to find what week the boys will weigh the same.

Solve the formula for the given variable (1pt each)

18. $M = T - R$ for T

19. $PV = nRT$ for T

Solve each proportion (2 pts each)

20. $\frac{-18}{n} = \frac{9}{2}$

21. $\frac{d}{5} = \frac{2}{4}$

22. $\frac{4}{12} = \frac{r+2}{16}$

23. $\frac{5}{w} = \frac{16}{5}$

Find each unit rate (1 pt each)

24. 26 crackers contain 156 calories, how many calories in 1 cracker?

25. a store developed 1024 photos in 8 hours, how many in 1 hour?

Percents (1 pt each)

26. what is 40% of 20.

27. what is 18% of 18?

28. 16 is 80% of what number?

29. 35 is what % of 60?

30. 200% of what number is 28?

31. 13% of what number is 80?

32. A zoo volunteer is responsible for feeding the animals in 15 exhibits. His duties cover 20% of the exhibits in the reptile house. How many exhibits are in the reptile house?

33. (3 pts) You have been offered a sales job at two different companies.

Company A offers you a base salary of \$38,000 with 13% commission on sales. You learn that the average sales at Company A are \$225,000.

Company Z offers you a base salary of \$65,000 with no commissions.

Which job will you take and why?

34. (2 pts) You have taken out a loan for your first car. The bank lends you \$15,000 at 3.5% interest for 5 years.

a) How much interest will you have paid on your loan?

b) How much *total* did the car cost you?

35. (1 pt) Estimate the tax on your purchase of \$49.54 with a tax rate of 5%.

Find the percent of change. Tell whether it is an increase or decrease. (2pts each)

36. from 60 to 66

37. from 48 to 12

38. from 19 to 26

39. from 100 to 200

40. (2 pts) A store buys cat food bags for \$10 each. They mark up the price by 60% .

a) what is the amount of the markup?

b) how much would a consumer pay for a bag of cat food at this store?

41. (2 pts) You have 2 store coupons, one for \$15 off your total purchase and one for 30% off your total purchase. You can only use one coupon.

a) if your total was \$42 which coupon would you use?

b) if your total was \$55 which coupon would you use?

EXTRA CREDIT (2 pts each)

1. solve the equation to find the value of x

$$4x + 13 - 2(3x + 16) + 24x - 17 = 5(2x + 1) - 18x + 79$$

2. The wholesale cost of an item is \$13,000. There is a markup of 82%. The item is then put on sale at 25% off. You use a coupon for \$40 off your total purchase. How much will you pay for this item?

Appendix J

Chapter 2 Test

Test on lessons in Chapter 2

1. $t + 5 = -35$ (1 point)

☐ -30☐ 40☐ -40☐ 30

2. $20 = -12 + v$ (1 point)

☐ 8☐ -32☐ -8☐ 32

3. $b + 32 = 220$ (1 point)

☐ 188☐ 252☐ -252☐ -188

4. $u - 15 = -8$ (1 point)

☐ -7☐ 7☐ 23☐ -23

5. $-\frac{1}{6} + h = \frac{1}{6}$ (1 point)

☐ $-\frac{1}{3}$ ☐ $\frac{1}{6}$

- ☐ 1/3
- ☐ 1/12
- ☐ -1/12

6. $x/2 = 12$ (1 point)

- ☐ 6
- ☐ 24
- ☐ 14
- ☐ 10

7. $2.4 = b/5$ (1 point)

- ☐ .48
- ☐ 7.4
- ☐ -2.6
- ☐ 12

8. $-52 = -4c$ (1 point)

- ☐ 13
- ☐ -13
- ☐ 168
- ☐ -168
- ☐ 56

9. The school band needs \$1680 to travel to a competition. They have already raised \$560. a) Write an equation that shows how much money they need to still earn. b) solve the equation to show how much money they still have to raise. (2 points)

10. An orange contains about 80 milligrams of vitamin C, which is 10 times as much as an apple contains. a) Write an equation that shows how much vitamin C is in an apple. b) solve the equation to find out how much vitamin C is in an apple. (2 points)

11. $3a + 12 = 30$ (1 point)

- ☐ -2
- ☐ 14
- ☐ 6
- ☐ 2

12. $2r + 20 = 200$ (1 point)

- ☐ 90
- ☐ 110
- ☐ 95
- ☐ 105

13. $5n + 6 - 3n = -12$ (1 point)

- ☐ 9
- ☐ -3
- ☐ 2.25
- ☐ -2.25
- ☐ -9

14. $\frac{3}{5}k + 5 = 7$ (1 point)

- ☐ 20
- ☐ $\frac{6}{5}$
- ☐ $\frac{10}{3}$
- ☐ $\frac{3}{10}$
- ☐ $-\frac{6}{5}$

15. $3x + 15 - 9 = 2(x + 2)$ (1 point)

- ☐ 8
- ☐ 2

- ☐ -1
- ☐ -2
- ☐ 1

16. $3(2x - 5) = 2(3x - 2)$ (1 point)

- ☒ -2
- ☐ all real numbers
- ☐ -19
- ☐ no solution
- ☐ 14

17. Justin and Tyler are beginning an exercise program to train for football. Justin weighs 150 lbs. and hopes to gain 2 lbs. per week. Tyler weighs 195 lbs. and hopes to lose 1 lb. per week. a) Write an equation that shows when the boys will weigh the same. b) solve the equation to find what week the boys will weigh the same. (2 points)

18. $M = T - R$ solve for T (1 point)

19. $PV = nRT$ solve for T (1 point)

20. Solve the proportion: $-18/n = 9/2$ (1 point)

21. $d/5 = 2/4$ (1 point)

22. $4/12 = r + 2/16$ (1 point)

23. $5/w = 16/5$ (1 point)

24. 26 crackers contain 156 calories, how many calories in 1 cracker? (1 point)

25. A store developed 1024 photos in 8 hours, how many in 1 hour? (1 point)

26. What is 40% of 20? (1 point)

27. What is 18% of 18? (1 point)

28. 16 is 80% of what number? (1 point)

29. 35 is what % of 60? (Round to the nearest hundreth.) (1 point)

30. 200% of what number is 28? (1 point)

31. 13% of what number is 80? (Round to the nearest hundreth) (1 point)

32. A zoo volunteer is responsible for feeding the animals in 15 exhibits. His duties cover 20% of the exhibits in the reptile house. How many exhibits are in the reptile house? (1 point)

33. You have been offered a sales job at two different companies. Company A offers you a base salary of \$38,000 with 13% commission on sales. You learn that the average sales at Company A are \$225,000. Company Z offers you a base salary of \$65,000 with no commissions. Which job will you take? Support your answer with a numeric reason.

(3 points)

34. You have taken out a loan for your first car. The bank lends you \$15,000 at 3.5% interest for 5 years.

A) How much interest will you have paid on your loan at the end of the 5 years?

B) How much total did the car cost you?

(2 points)

35. Estimate the tax on your purchase of \$49.54 with a tax rate of 5%.

(1 point)

36. a) Find the % of change from 60 to 66.

b) Is it an increase or decrease?

(2 points)

37. a) Find the % of change from 48 to 12.

b) Is it an increase or decrease?

(2 points)

38. a) Find the % change from 19 to 26

b) Is it an increase or decrease?

(2 points)

39. a) Find the % change from 100 to 200.

b) Is it an increase or decrease?

(2 points)

40. A store buys cat food bags for \$10 each. They mark up the price by 60%. A) What is the amount of the markup? B) How much would a consumer pay for a bag of cat food at this store?

(1 point)

41. You have 2 store coupons, one for 15% off your total purchase and one for 30% off your total purchase.

You can only use one coupon. A) If your total was \$42, which coupon would you use? B) If your total was \$55, which coupon would you use?

(1 point)

42. Extra Credit:

Solve the equation for x:

$$4x+13-2(3x+16)+24x-17=5(2x+1)-18x+79$$

(2 points)

43. Extra Credit:

The wholesale cost of an item is \$13,000. There is a markup of 82%. The item is then put on sale at 25% off. You use a coupon for \$40 off your total purchase. How much will you pay for this item?

(1 point)

Appendix K

Algebra Chapter 2

Student #	Quiz Scores (%)		Test Scores (%)	
	computer	paper	computer	paper
0038	67	85	85	89
0595	95	97	94	102
2168	90	94	98	103
1298	90	94	87	94
2176	71	70	76	79
0811	81	97	86	101
1215	76	80	68	84
1559	95	80	77	90
0215	86	97	78	91
1520	86	83	68	87
0618	76	91	78	86
1171	71	91	94	102
2144	62	67	54	62
1033	81	94	92	101
1859	52	64	51	63
1286	57	79	72	86
1837	67	88	75	97
2147	62	79	65	81
1678	90	97	104	104

